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REPORT ON MODIFICATION OF AIM-4D
FALCON MISSILE CONTAINER TO ACCOMMODATE
GUIDANCE AND CONTROL SECTION OF
AIM-7E/E2 SPARROW MISSILE

39

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REPORT ON MODIFICATION OF AIM-4D FALCON MISSILE CONTAINER TO ACCOMMODATE GUIDANCE AND CONTROL SECTION OF AIM-7E/E2 SPARROW MISSILE

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ABSTRACT

A shortage of usable AIM-7 missile containers existed and the refurbishment operations were not capable of providing the quantity required. Also the new procurement containers would not be available for several months. Therefore, the possibility of an interim and/or back-up container was investigated.

An AIM-4D Falcon container (FSN 8140-546-3527) was modified to accommodate the guidance and control sections of the AIM-7E/E2 Sparrow missile. The modification included removal of part of the internal structure of the container and replacement of the rubberized hair cushioning material with 2.0 pound density polyethylene cushioning material.

The modified container with an instrumented mock-up of the missile and its components was subjected to and passed two series of rough handling tests in accordance with Federal Test Methods Standard No. 101B, Methods 5005 and 5008, for Level A protection.

The modification work was to be accomplished by the personnel of Hill AFB, Utah. Prior to approval of the modification work, a fit and function test was performed on the first modified container. This test was satisfactorily completed.

Therefore, from the results obtained from the rough handling tests and the fit and function test, it was concluded that the container would provide adequate shock protection for the missile and satisfy an urgent need for an interim and/or back-up container for the guidance and control sections of the AIM-7E/E2 Sparrow missile.

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INTRODUCTION:

This project was initiated to investigate the possibility of modifying an existing container to accommodate the guidance and control (G&C) sections of the AIM-7E/E2 Sparrow missile as requested by ASD/ASOM.

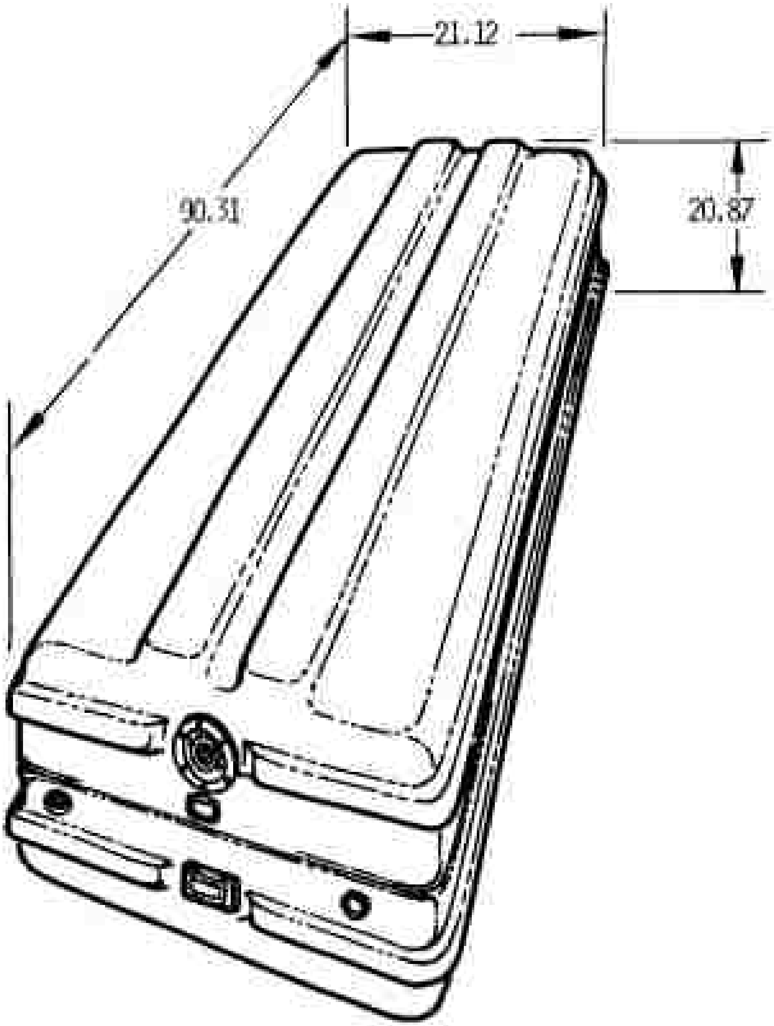
A shortage of useable Sparrow missile containers existed due to a delay in the procurement of new containers from Metric Systems Incorporated, Fort Walton Beach, Florida. The new containers were critically needed for shipment and storage of the Sparrow missile components manufactured by Raytheon Company, Lexington, Massachusetts, which were ready for shipment. The refurbishment rate of the old reuseable Sparrow missile containers was not rapid enough to provide the quantity required. Therefore, if a modified container could be developed, the procurement quantity of new containers could be held to a minimum and Raytheon Company could be provided with containers prior to the estimated delayed production date of new containers.

A shipping and storage container for the AIM-7E/E2 Sparrow missile must provide Method IId protection, maximum fragility level of 25 G for the missile, and sufficient space to accomodate the missile components.

A large quantity of surplus AIM-4D Falcon missile containers was available for use. Therefore, two of these containers were obtained by AFPEA for possible redesign, modification, testing, and evaluation.

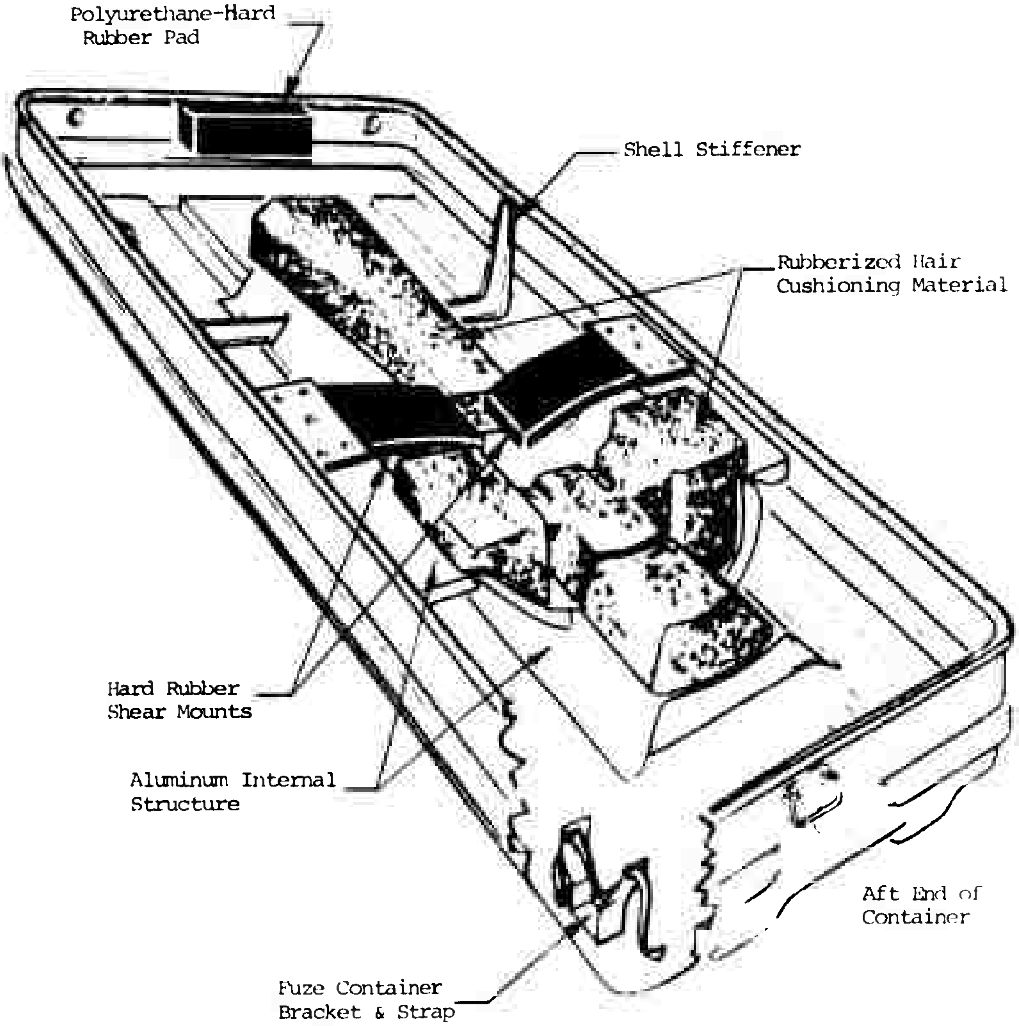
DESCRIPTION OF AIM-4D FALCON MISSILE CONTAINER (Figures 1, 2, and 3):

The AIM-4D missile container (FSN 8140-546-3527) is a two piece, aluminum construction with inside dimensions of approximately 88 x 19-1/4 x 18 inches. The suspension system is composed of 3-inch thick rubberized hair cushioning material supported by an aluminum internal structure in both the upper and lower sections. In addition, a hard rubber shear mounting arrangement is utilized to prevent longitudinal shifting of the missile toward the aft end of the container. Located in the forward end of the container, both upper and lower halves, are hard rubber pads bonded to polyurethane cushioning material, designed to cushion the missile from shock in the forward longitudinal direction. Also, located in the upper half of the container is a wire desiccant basket capable of holding approximately 17 packs of 8 units each of desiccant. In the lower half of the container is located a fuse container bracket and strap. Both sections of the container have a container shell stiffener located approximately 25 inches from the forward end of the container. Located in the forward end of the container are the humidity indicator, the outlet valve, and the breather valve. The container provides Method IId protection and is sealed by a continuous 0-ring type rubber gasket located between the upper and lower halves of the container. Closure of the container is attained by fourteen eccentric-cam latches located six on each side and one on each end of the container.



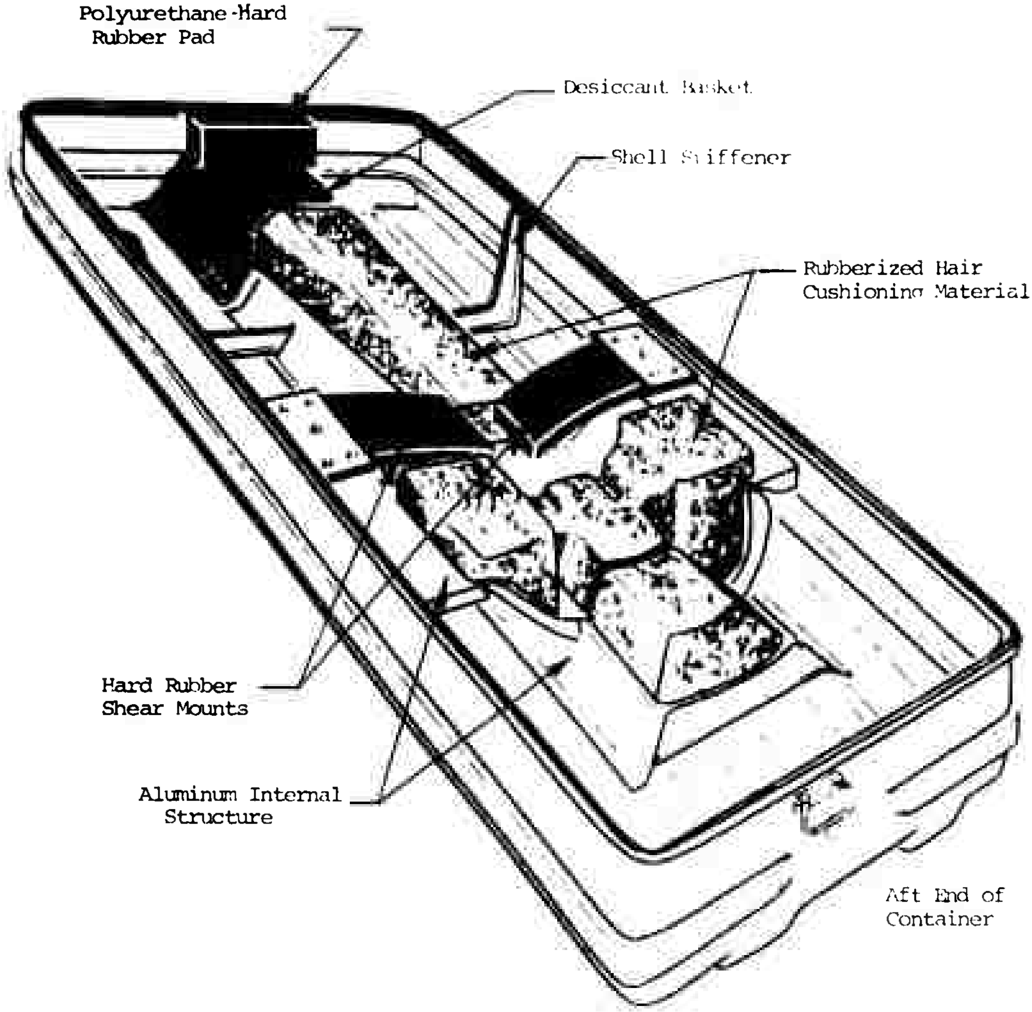
AIM-4D FALCON MISSILE CONTAINER

FIGURE 1



AIM-4D FALCON MISSILE CONTAINER
LOWER HALF
(UNMODIFIED)

FIGURE 2



AIM-4D FALCON MISSILE CONTAINER
UPPER HALF
(UNMODIFIED)

FIGURE 3

MODIFICATION OF CONTAINER:

The overall dimensions of the container provide sufficient space for the G&C sections of the AIM-7E/E2 Sparrow missile and its components. The components, shipped in the container with the G&C sections of the missile, are the antenna and the four forward and the four aft fins (the forward fins are often referred to as the wings).

The combined Sparrow missile G&C sections are 8 inches in diameter and 80.26 inches in length. The AIM-4D Falcon missile is 6.4 inches in diameter and approximately the same length as the G&C sections of the Sparrow missile; therefore, the larger diameter Sparrow missile could not be inserted directly into the container with the present thickness of cushioning material and attain closure of the container. The space available between the upper and lower internal structure of the closed container is approximately 12.4 inches. The Sparrow missile being 8 inches in diameter would allow for only 2.2 inch thick cushioning material on both top and bottom. No known cushioning material could provide the shock protection required (maximum 25 G) at the allowable thickness. Therefore, the following design changes were specified: (1) removal of the internal structure from the lower section of the container to provide for the required cushion thickness, (2) removal from both sections of the container of the rubberized hair cushioning material and the hard rubber shear mounts, and (3) removal of the fuse container bracket from the lower half of the container.

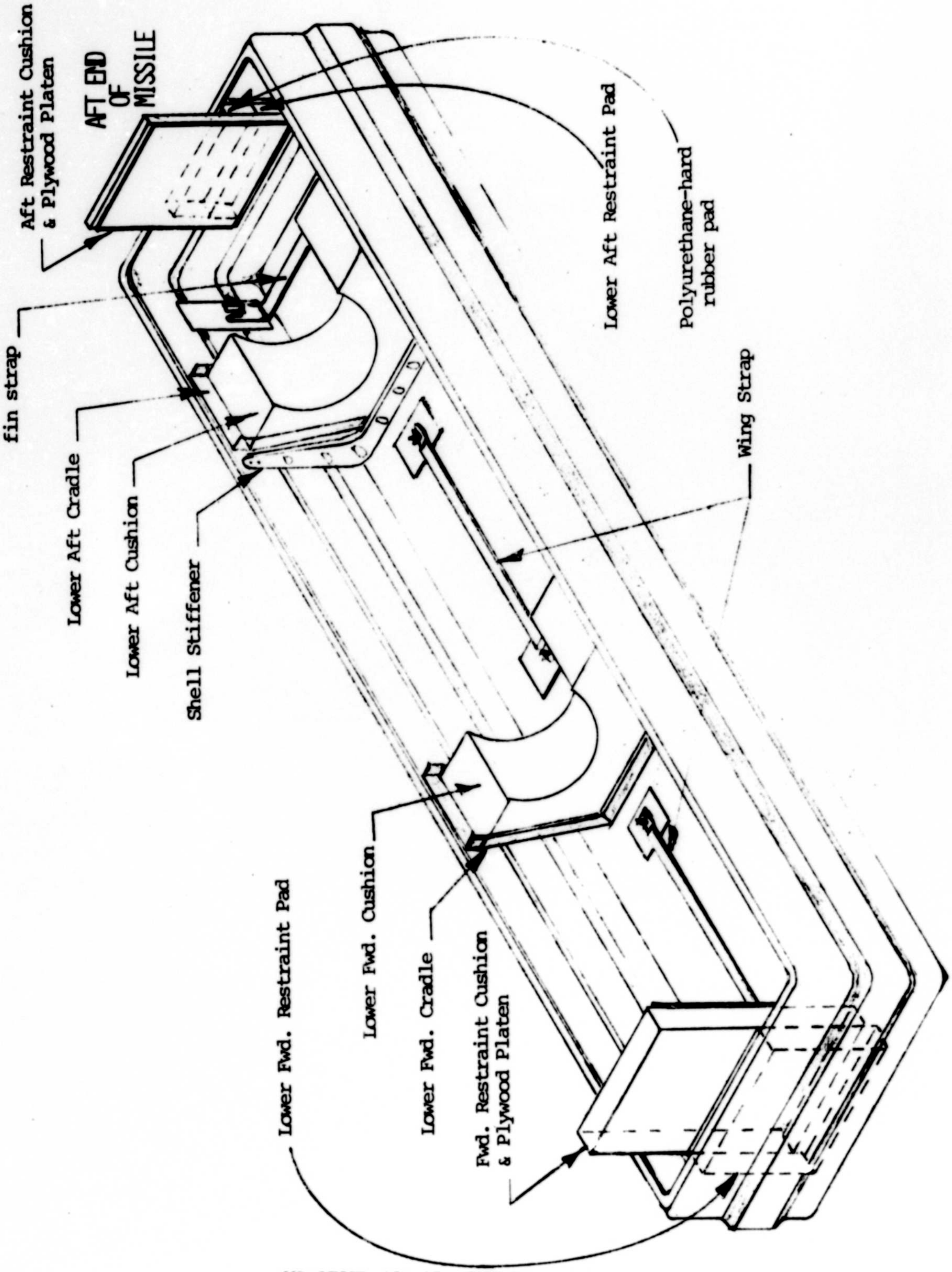
DESCRIPTION OF MODIFIED CONTAINER (Figures 4 and 5):

The modification of the container did not affect the closure latches or seal; therefore, the modified container will still provide Method IId protection for the missile and its components.

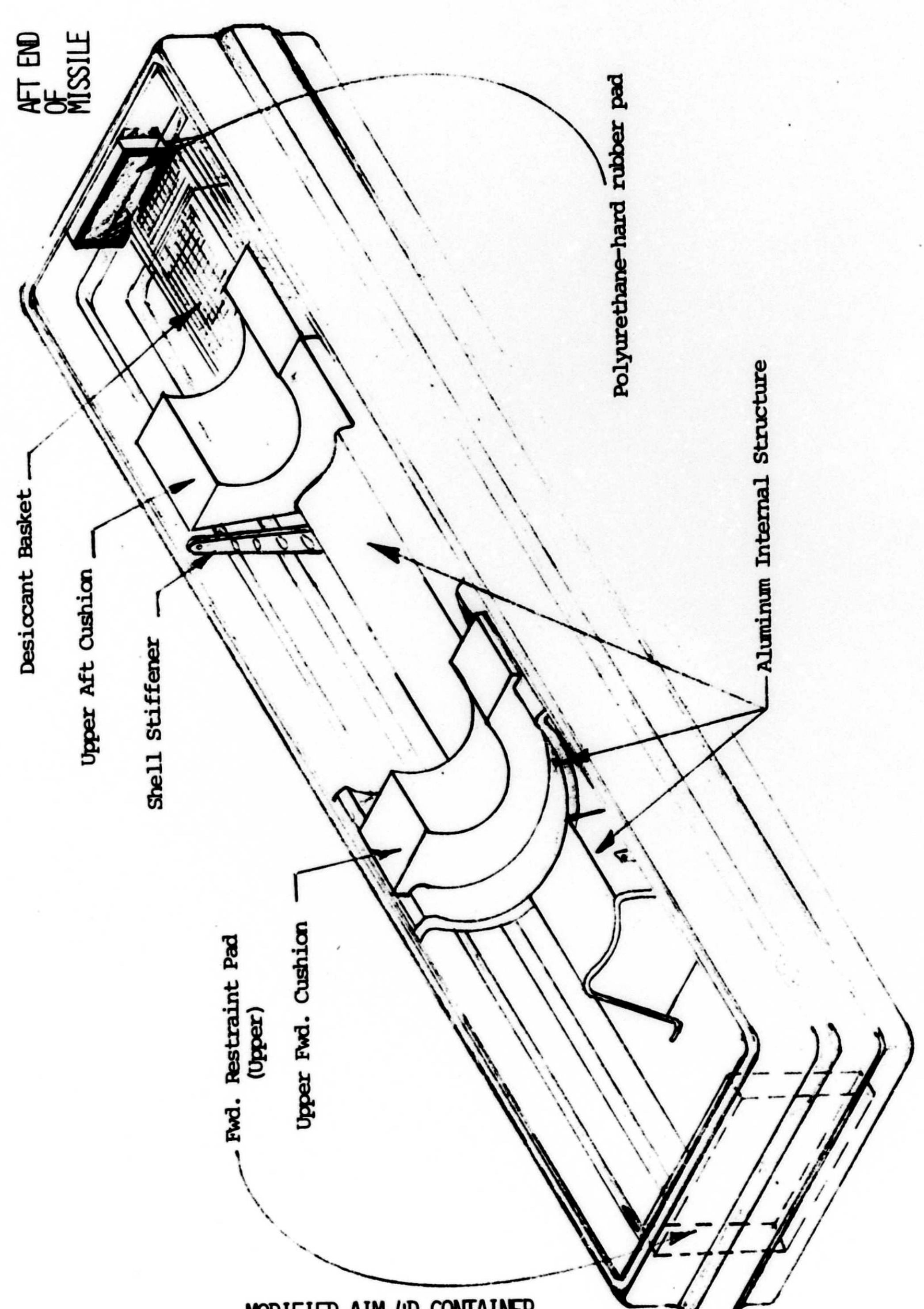
The modified lower half of the container is composed of the shell, the shell stiffener and the polyurethane hard rubber pad from the original container. To position the lower main cushions and provide additional strength to the container, which was greatly weakened by the removal of the lower internal structure, special cushion cradles were designed (see figure 6). Due to present AFPEA shop limitations, the test model cradles did not have the formed edges and welded seams as the figure depicts, and were bolted, rather than welded, to the container walls by 1/4-20 cap screws.

The cushioning material specified is unicellular polyethylene having a density of 2.0 pounds per cubic foot and shaped as shown in figures 4, 5, and 7. The cushions for the test container were composed of bonded sections of the specified material.

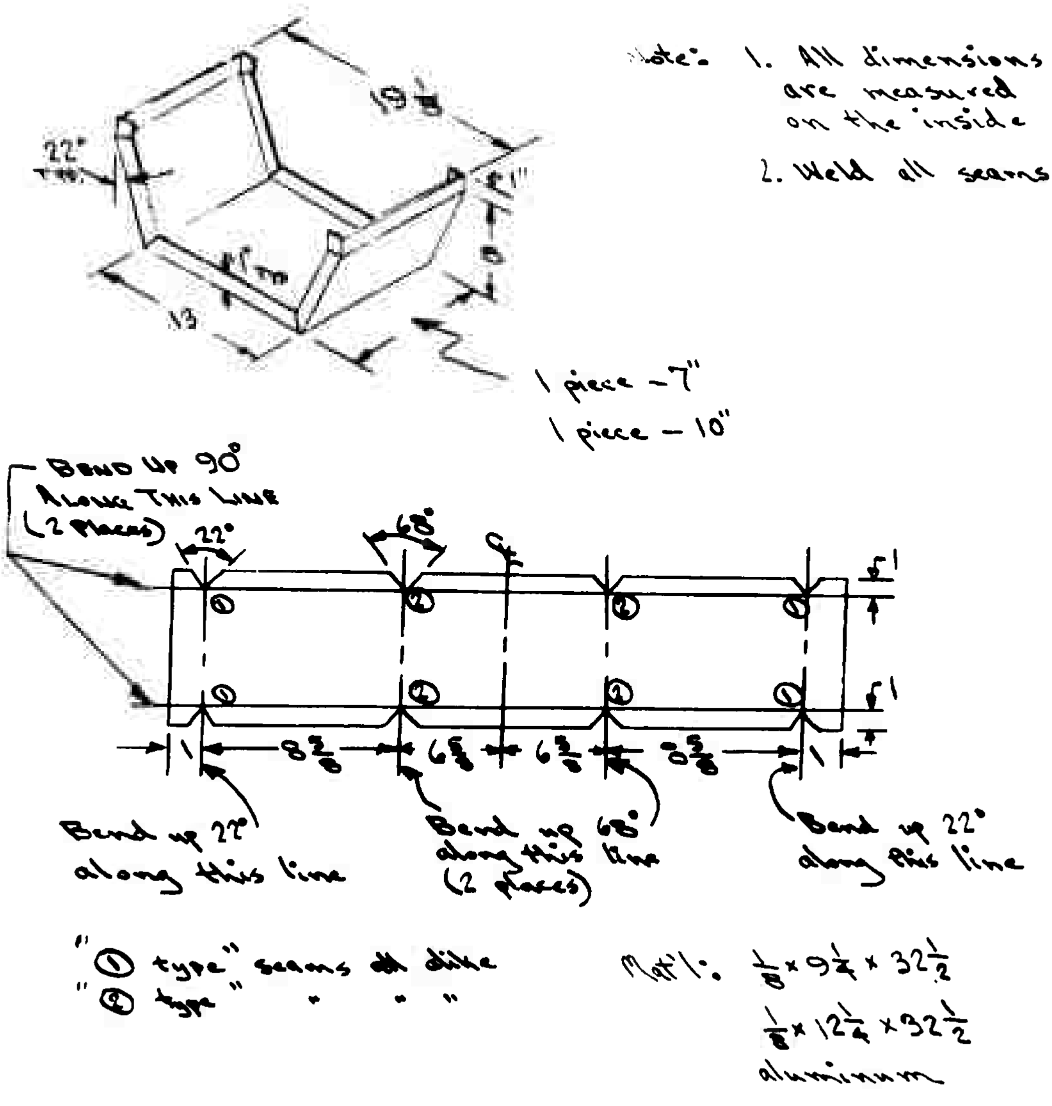
Located between the end restraint cushions and the main cushion cradles are the wing and fin hold-down provisions (see figure 4). Each wing strap constrains two wings and the fin strap holds all four fins in position. (See Appendix A



MODIFIED AIM-4D CONTAINER (LOWER HALF) FIG. 4

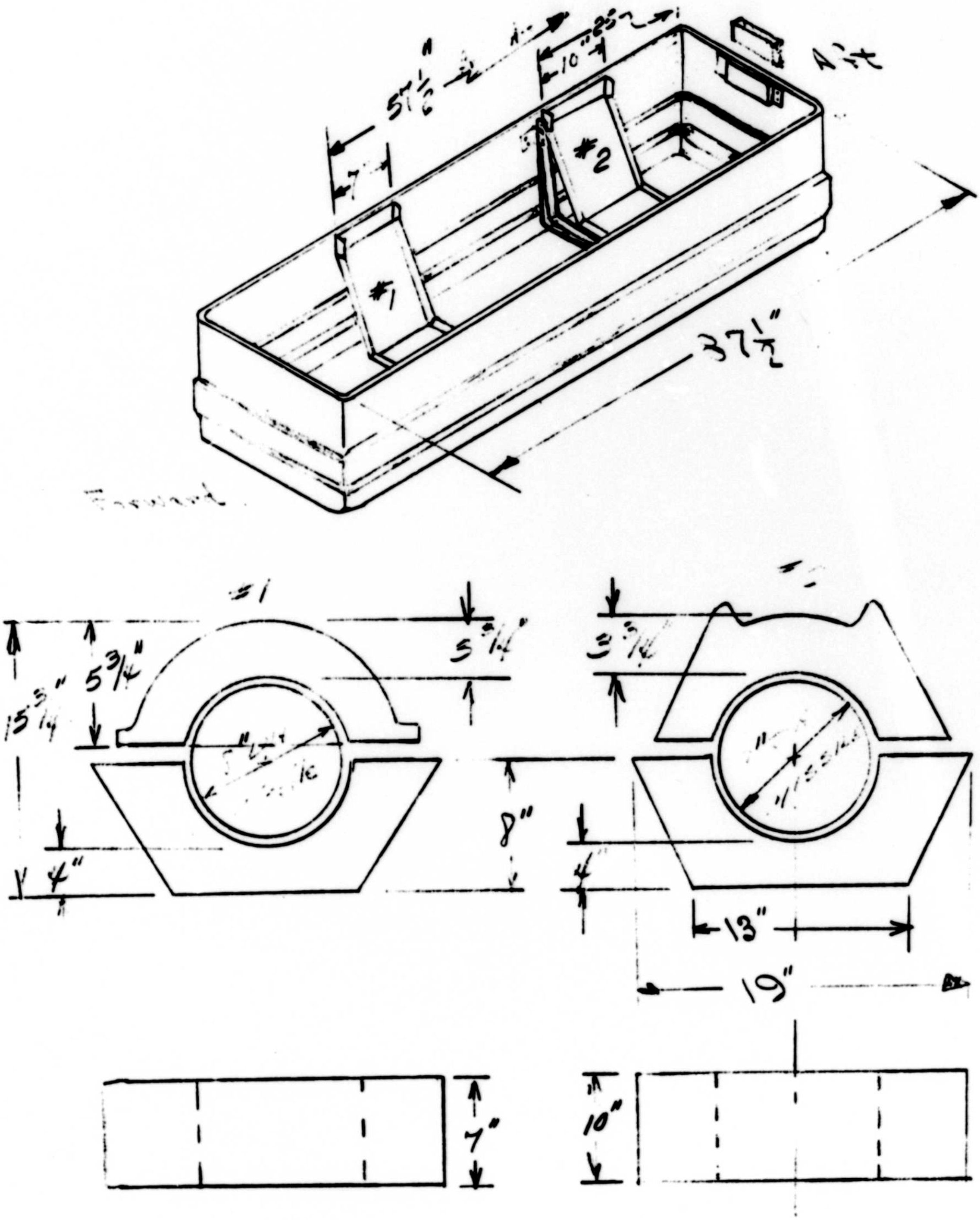


MODIFIED AIM-4D CONTAINER
(UPPER HALF)
FIGURE 5



CUSHION CRADLES

FIGURE 6



MAIN CUSHIONING DETAIL

AND

MODIFIED CONTAINER BOTTOM

FIGURE 7

for dimensions of wings and fins.)

In the upper half of the container along the internal structure are located mounting provisions for the antenna. The antenna is approximately 1/2 x 1 x 69 inches.

Two upper main cushions, partially conforming to the configuration of and bonded to the upper internal structure, are positioned so as to correspond to the locations of the lower main cushions and, thereby, forming two mated pair of cushions when the container is closed (see figures 4, 5, and 7).

(See Appendix C for photographs of the modified container on which the fit and function test was conducted at Hill AFB, Utah.)

DESCRIPTION OF MISSILE "MOCK-UP" AND COMPONENTS:

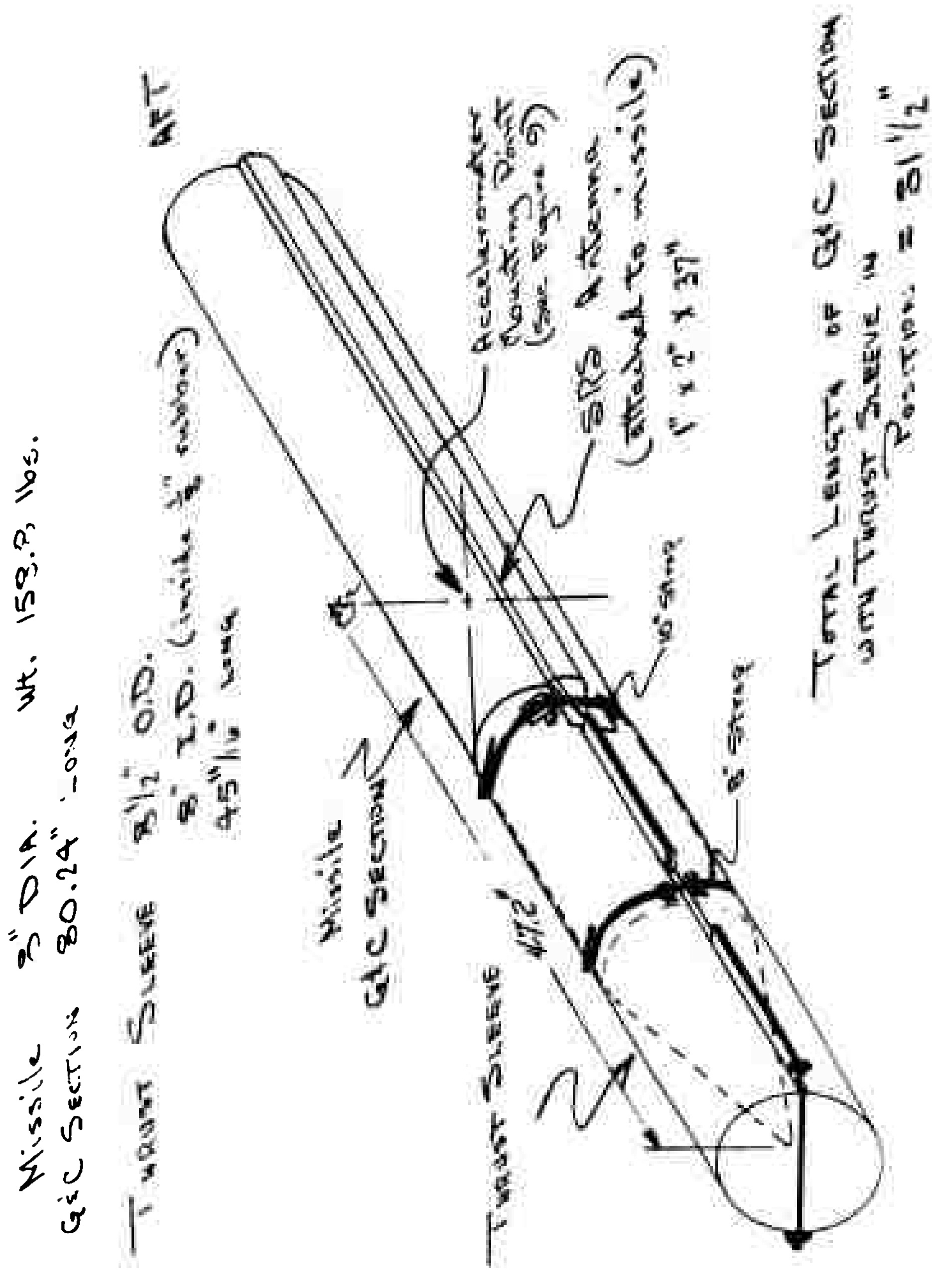
The missile prototype was fabricated in the AFPEA shop and was a composite of aluminum pipe, lead, and wood. The prototype approximated the general properties of the G&C sections of the AIM-7E/E2 missile (for specifics, see Appendix A). The radome of the missile is very sensitive; therefore, an aluminum thrust sleeve is clamped over this section of the missile prior to placement into the container (see figure 8). This thrust sleeve was also used on the test missile "mock-up".

The wings, fins, and antenna present in the container during the second series of rough handling tests were the actual items. It should be noted that the missile components were not present in the container during the first series of tests.

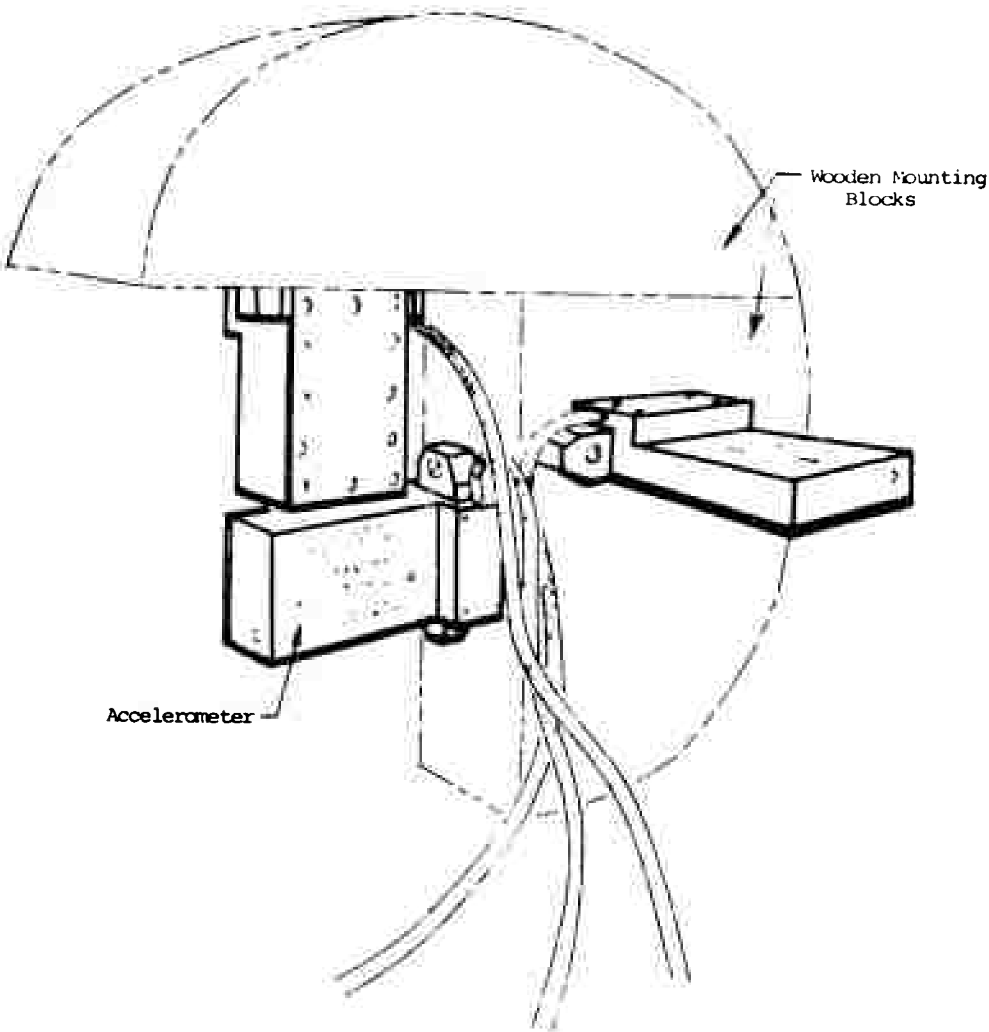
The missile "mock-up" was instrumented with 3 strain gage accelerometers (50 G capacity) mounted in a triaxial configuration located approximately at the center of gravity (see figures 8 and 9).

TEST PROCEDURES:

Two series of rough handling tests were performed on the modified AIM-4D container. A report on the first series of tests is included in this report in Appendix B. The second series of test results is described in the Test Results section of this report. Both series of tests were conducted in accordance with Method 5005, Cornerwise Drop Test, and Method 5008, Edgewise Drop Test, of Federal Test Method Standard No. 101B for Level A protection. The drop height specified in Federal Test Method Standard No. 101B corresponds to the drop height requirement specified in MIL-P-116E for this particular container weight range. The loaded container used in the second series of tests weighed approximately 350 pounds; therefore, a 24-inch drop height was required.



MISSILE & THRUST SLEEVE
FIGURE 8



ACCELEROMETER MOUNTING CONFIGURATION
FIGURE 9

A pressure retention check was conducted on an unmodified AIM-4D container with an old and with a new closure gasket (8140-877-5476). In both tests, the container was subjected to a 1.5 PSI internal air pressure as per the original container Production Specification No 802031.

INSTRUMENTATION AND TEST EQUIPMENT:

For a description of the instrumentation, accelerometer mounting provisions, and test equipment used for the rough handling tests, see pages B-3 and B-4 of Appendix B and figure 9.

A simple water manometer was used to conduct the pressure retention tests.

TEST RESULTS:

Slight permanent damage was received by the container during the second series of tests; however, it was not extensive enough to render the container unuseable. The lower corners of the container were deflected inward from impact with the striking surface. Although the container was deformed, the amount of damage was considered negligible.

Upon each impact of the container with the striking surface, several closure latches were released, but received no apparent damage. On each test, one side latch and the end latch on the impact end of the container were released.

The straps which held the wings and fins in position were loosened slightly, allowing the missile components to shift out of their proper position.

The results from the second series of instrumented drops were slightly higher than those obtained from the first series. The higher readings can be attributed to two possible causes--the additional weight provided by the missile components and/or the partial breakdown of the cushioning material resulting from repeated impact. The missile components (wings, fins, and antenna) weigh an approximate combined total of 50 pounds.

As was previously experienced in the first series of tests, some disagreement existed between the results obtained from the oscilloscope and those from the oscillograph, for the vertical axis. Also in this series of drops, as was done in the previous series, the oscilloscope reading considered the most accurate was used to calculate the resultant acceleration sustained by the instrumented missile "mock-up". The following table shows the data obtained.

TABLE I

Method/ Orientation	Drop Number	Vertical Os'scope	Axis Os'graph	Lat.Axis Os'graph	Long.Axis Os'graph	Resultant
Edgewise/ Fwd End	1	17.84	16.66	.96	2.94	18.1
	2	17.62	16.66	.96	1.96	17.7
						Avg. 17.9
Edgewise/ Aft End	3	18.12	15.19	.96	1.96	18.2
	4	18.35	16.17	.96	1.96	18.5
						Avg. 18.35
Cornerwise/ Fwd End	5	13.36	11.27	5.73	.98	14.6
Cornerwise/ Aft End	6	12.52	10.29	3.82	.98	13.2

All readings are in G's. The duration of the primary shock pulse was approximately 65 milliseconds.

The container with the old closure gasket, when subjected to the 1.5 PSI internal air pressure, did not retain the pressure. The application of a soapy solution indicated that the closure gasket was not sealing properly. Various reasons could be attributed to the failure of the gasket to seal, namely: damage to the seal area, cracks in the gasket, compression set of the gasket, or damage to the closure latches.

The 1.5 PSI internal air pressure test conducted on the container after the old gasket had been replaced with a new one resulted in a retention of pressure for 1 hour without loss. Thus, indicating that a proper seal had been affected.

CONCLUSIONS:

Due to the urgent need for containers and the additional expense involved, it was concluded that forklift handling provisions would not be incorporated into the modification design.

Since the final inspection of the tested container revealed no appreciable amount of permanent damage and the results obtained from the instrumented drop tests were less than the 25 G fragility level for the missile, it was concluded that the modified AIM-4D container will provide adequate shock protection for the G&C sections of the AIM-7E/E2 Sparrow missile.

To resolve the problem of the wing and fin straps becoming loose and allowing movem· of these components, it was concluded that internal, external toothed lock washers shall be placed between the straps and the wing nuts at all six fastening locations on the final assembly.

Since the modified test container passed the rough handling tests, the unmodified container passed the pressure retention, and the container modified at Hill AFB, UT passed the fit and function test, it was concluded that the modified AIM-4D container would be suitable for shipment and storage of the guidance and control sections of the AIM-7E/E2 Sparrow missile.

RECOMMENDATIONS:

It is recommended that all container components found to be missing or defective be replaced with new parts prior to shipment to the missile manufacturer's plant. It is also recommended that a 1.5 PSI pressure retention check be conducted on 100% of the containers modified to insure that all components seal properly.

Since this is a modified container design and not of the optimum configuration, it is recommended that this container design not be used for procurement of new containers.

APPENDIX A

DESCRIPTION OF AIM-7E/E2 MISSILE

ATTACHMENT 2 TO EXHIBIT A

COMPONENT AIM 7E-2	DRAWING NO.	INCHES O/A DIMENSIONS	WT	CG STATION LOCATION	FRAGILITY FACTOR	REMARKS
Guidance & Control Sec.	2055-1030 380522 380523 402519 380521	80.26 x 8.0 Dia	158.8	47.2	30G	1. Radome must not be in contact with cushioning material 2. Exhaust chimney is located at stations 54.57 to 56.91. Dimensions are 2.34" x 2.0625" x 1.125". 3. Launch lugs are located at missile station 68.1. See Figure 1 attached.
Warhead		15.0 x 8.0 Dia	70.6	N/A	30G	
Motor		52.01 x 8.0 Dia	156.0	*107.0	30G	1. Launch lugs are located at missile station 92.3. See Figure 1 attached for details.
Fins (FWD)	380031	18.625 x 16.03 x 3.0	34.4	N/A	N/A	1. Fins are detached and packaged inside G&C container. (NOTE: See Exhibit - A wing and fin container shall be designed to store and handle the components at the missile sites).
Fins (AFT)	2070-5018	18.50 x 12.56 x .87	12.4	N/A	N/A	1. See Remarks Above.
Rear AFT Antenna	2146-1191	40.0 x 1.625 x .875	2.2	N/A	N/A	1. The wave guide is detached when missile components are separated. The AFT wave guide shall be packaged insid the motor container.
Rear FWD Antenna	2146-5018	30.5 x 1.625 x .875	4.9	N/A	N/A	1. See Above.
SRS Antenna	2146-5028	37.0 x 1.0 x 2.1	1.0	N/A	N/A	1. The SRS antenna is detached and packaged inside the G& container.

* The CG location for the AIM 7E motor section is identified by the station number of the assembled missile.

RFP F33615-70-R-1271

DESCRIPTION OF AIM-7E/E2 MISSILE
(REFERENCE RFP F 33615-70-R1271)

APPENDIX B

PERFORMANCE EVALUATION REPORT

SGTEB Report No. 24
Project No. 70-28-C-6-(6)

E. P. MORAVEC
Physicist

R. QUINTER
Mechanical Engineer

AIR FORCE PACKAGING EVALUATION AGENCY
DSPEB

JULY 1970

PERFORMANCE EVALUATION OF MODIFIED AIM-4 CONTAINER TO ACCOMMODATE AIM-7E/E2 MISSILE

ABSTRACT

A container configuration proposed to be used as a shipping and storage container for the AIM-7E/E2 missile was subjected to a standard "rough-handling" test cycle. The container configuration consisted of a modified AIM-4 missile container with polyethylene cushioning pads. The test of the container was conducted in accordance with Method 5005 and Method 5008 of Federal Test Method Standard 101B, Level A. Instrumentation was employed to measure the acceleration sustained by the missile prototype "mock-up". From the results obtained, it was concluded that the modified AIM-4 container would provide adequate protection.

I. PURPOSE OF TEST: The test is intended to determine whether or not a modified AIM-4 Falcon missile container with a polyethylene cushioning suspension constitutes a satisfactory shipping and storage container for the AIM-7E/E2 Sparrow Missile, and to determine the peak accelerations sustained by the missile when the assembled container is tested according to Method 5005 and Method 5008 of Federal Test Method Standard No. 101B, Level A protection.

II. DESCRIPTION OF TEST CONTAINER:

a. Container: The container tested was the standard aluminum AIM-4 missile container (FSN 8140-546-3527) which was modified by removing the sheet metal cushioning pad supports in the lower half of the container and substituting sheet metal cushioning pad supports compatible with the polyethylene foam cushioning pads. Polyethylene cushioning pads were substituted for the existing AIM-4 missile cushioning pads.

b. Cushioning Suspension: The shape, dimensions, and location of the side cushion pads are illustrated in Sketch #1. The pads were fabricated from polyethylene foam having a density of two pounds/cubic foot. End pads (not shown in Sketch #1) were composites consisting of polyethylene pads, 2.0 pound per cubic foot density, and neoprene foam rubber pads which were components of the original AIM-4 missile container. The aft pad consisted of 1/2 inch thick polyethylene foam with a 10 inches in diameter load distributor of 1/4 inch thick plywood and two, 1 1/2 inch thick, 8 inches long, 3 1/2 inches wide, upper and lower, neoprene foam pads, which bore upon the container end. The nose pad consisted of 3 1/2 inches thick polyethylene foam with a 12 inches in diameter load distributor of 1/4 inch plywood and was supported by solid neoprene rubber blocking which bore upon the container end.

c. Missile Mock-Up Prototype: The missile "mock-up" was fabricated in-house and was designed to approximate the gross properties of the AIM-7E/E2, Sparrow Missile. Weight, length, diameter, and location of the center of gravity were approximately those of the missile. The "mock-up" consisted of a composite of wood, lead, and aluminum pipe. Specifics of the prototype are: weight, 158.8 pounds; length, 80 1/4 inches; diameter, 8 inches; location of center of gravity, 47.2 inches from the nose of the prototype.

A protective steel sleeve which is a component part of the AIM-7 missile container was clamped about the nose of the missile prototype.

III. INSTRUMENTATION AND TEST EQUIPMENT: Components of the acceleration measuring system used are as follows: accelerometers, Statham Instruments, Inc., strain gauge, model A5-50-350; instrument amplifier, Kintel, Model 112A; Offner Dynograph oscillographic recorder, Offner Industries, type 504A; and Hughes Memoscope oscilloscope, Hughes Aircraft Company, Model 105A.

Three model A5-50-350 strain gauge accelerometers were mounted in an orthogonal triaxial configuration. The mount was located in a plane passing through the prototype center of gravity and perpendicular to the longitudinal axis of the missile. Attachment of the mount was to the inner surface of the wall of the 8 inch diameter aluminum pipe. One accelerometer was aligned with its sensitivity axis oriented vertically. Two accelerometers were aligned with their sensitivity axises oriented horizontally; one axis parallel to the longitudinal axis of the prototype and one perpendicular to it.

The electrical analog signals generated by the accelerometers were amplified by the Kintel amplifiers and reproduced in graphic form on the Offner Dynograph oscillographic recorder and Memoscope oscilloscope. All three signals were recorded on the oscillograph and the signal from the vertical accelerometer was recorded on the oscilloscope.

Calibration of the instrumentation was effected by shunting one leg of each strain gauge accelerometer bridge with a precision 20,000 ohm resistor to produce a voltage output directly related to the calibration coefficient of the accelerometer. Accelerometers were calibrated mechanically at a Standardization Laboratory.

IV. TEST PROCEDURE: One assembled modified AIM-4 missile container was tested in accordance with Method 5005, Cornerwise Drop Test and Method 5008, Edgewise Drop Test, Level A, of Federal Test Method Standard No. 101B. For Method 5005, the procedure consisted of placing one end of the container on blocks, so that one corner was 6 inches above the floor and an adjacent corner was 12 inches above the floor, raising the opposite end to a height of 24 inches above the tile faced concrete floor, and permitting the elevated end to impact on the floor. The test procedure was repeated on the other end of the container. The prototype was instrumented to measure and record the acceleration resulting from the impact.

V. TEST RESULTS: No permanent damage was observed to either the container or the cushioning suspension as a consequence of the drop test series. During the course of the test, four container closure latches released due to the impact loading, but the latches apparently sustained no permanent mechanical damage. Two of the released latches were located on the container side, and one was located on either end of the container. The upper half of the nose pad shifted toward the nose end of the missile approximately two inches, and the upper half of the aft end pad shifted toward the nose end of the missile approximately one inch. No other damage was observed.

Acceleration sustained by the missile prototype was measured by orthogonal triaxial accelerometers located at the center of gravity of the prototype. The vertical axis was monitored by an oscilloscope and an oscillograph, and the two horizontal axes were monitored by an oscillograph. Due to frequency distortion of the data pulse as a consequence of inadequate

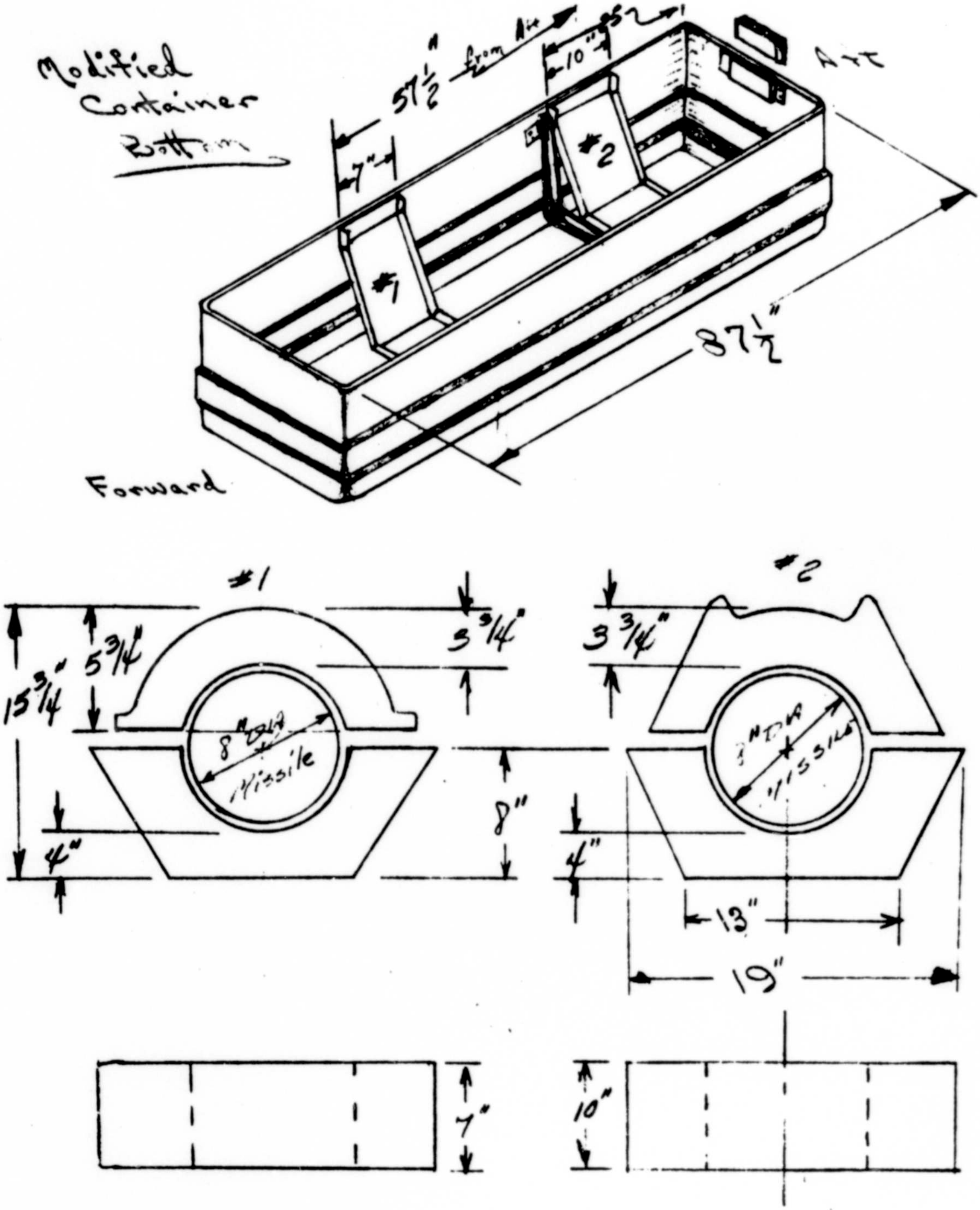
oscillograph bandwidth to reproduce the data pulse, some disagreement exists between the results obtained on the oscilloscope and oscillograph for the vertical axis. For the vertical axis, the data recorded on the oscilloscope was used in calculating the vector resultant of the triaxial components of the acceleration, as it was considered to be the more accurate of the two. The acceleration sustained by the missile prototype is shown in the following table:

METHOD / ORIENTATION	DROP NUMBER	VERTICAL AXIS (OSCILLOSCOPE)	VERTICAL AXIS (OSCILLOGRAPH)	LATERAL AXIS (OSCILLOGRAPH)	LONGITUDINAL AXIS (OSCILLOGRAPH)	RESULTANT OF COMPONENTS
Edgewise, Nose End	1	12.2G	11.4G	1.3G	1.4G	12.4G
	2	12.2G	11.5G	.7G	1.2G	12.3G
					Average	12.4G
Edgewise, Aft End	3	15.2G	12.4G	1.1G	2.0G	15.4G
	4	16.7G	13.8G	1.4G	2.2G	16.9G
					Average	16.2G
Cornerwise, Aft End	5	9.6G	8.1G	3.7G	2.1G	10.5G
	6	11.2G	7.0G	3.7G	2.0G	12.0G
					Average	11.2G
Cornerwise, Nose End	7	12.5G	10.4G	4.6G	2.4G	13.6G
	8	12.7G	10.6G	4.5G	0G	13.5G
					Average	13.6G

The duration of the principal acceleration pulse was approximately 60 milliseconds.

VI. RECOMMENDATIONS AND CONCLUSIONS: Based on the observations that the modified AIM-4 missile container sustained no permanent damage and that the missile prototype sustained less than 25 G peak acceleration, it is concluded that the modified AIM-4 missile container configuration is suitable for use as a shipping and storage container for the AIM-7E/E2 missile.

The cushioning pads should be secured to the container to prevent shifting of the pads.



cushions can be made in two pieces

Sketch #1

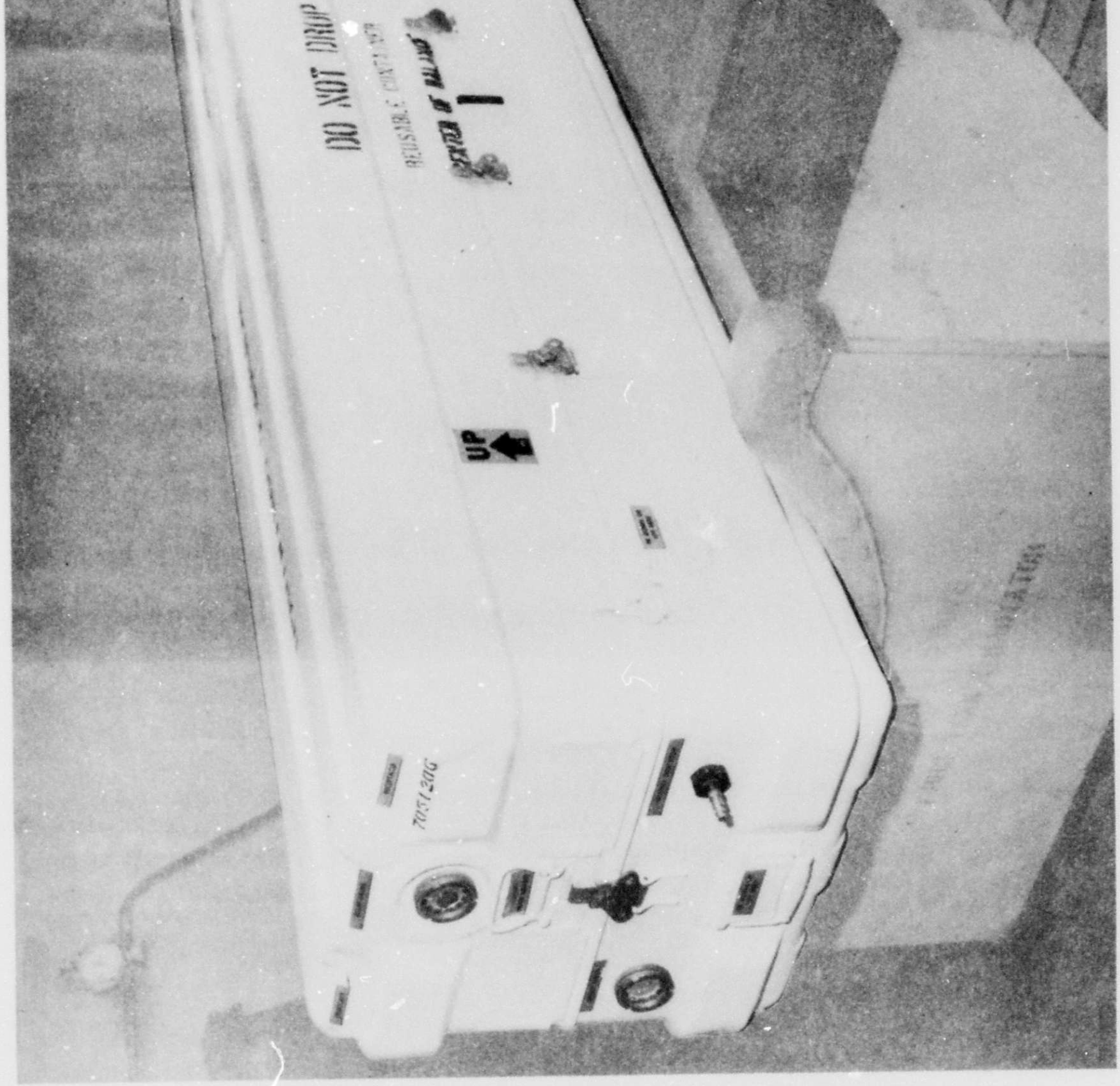
PUBLICATION REVIEW

This report has been reviewed and
is approved by:

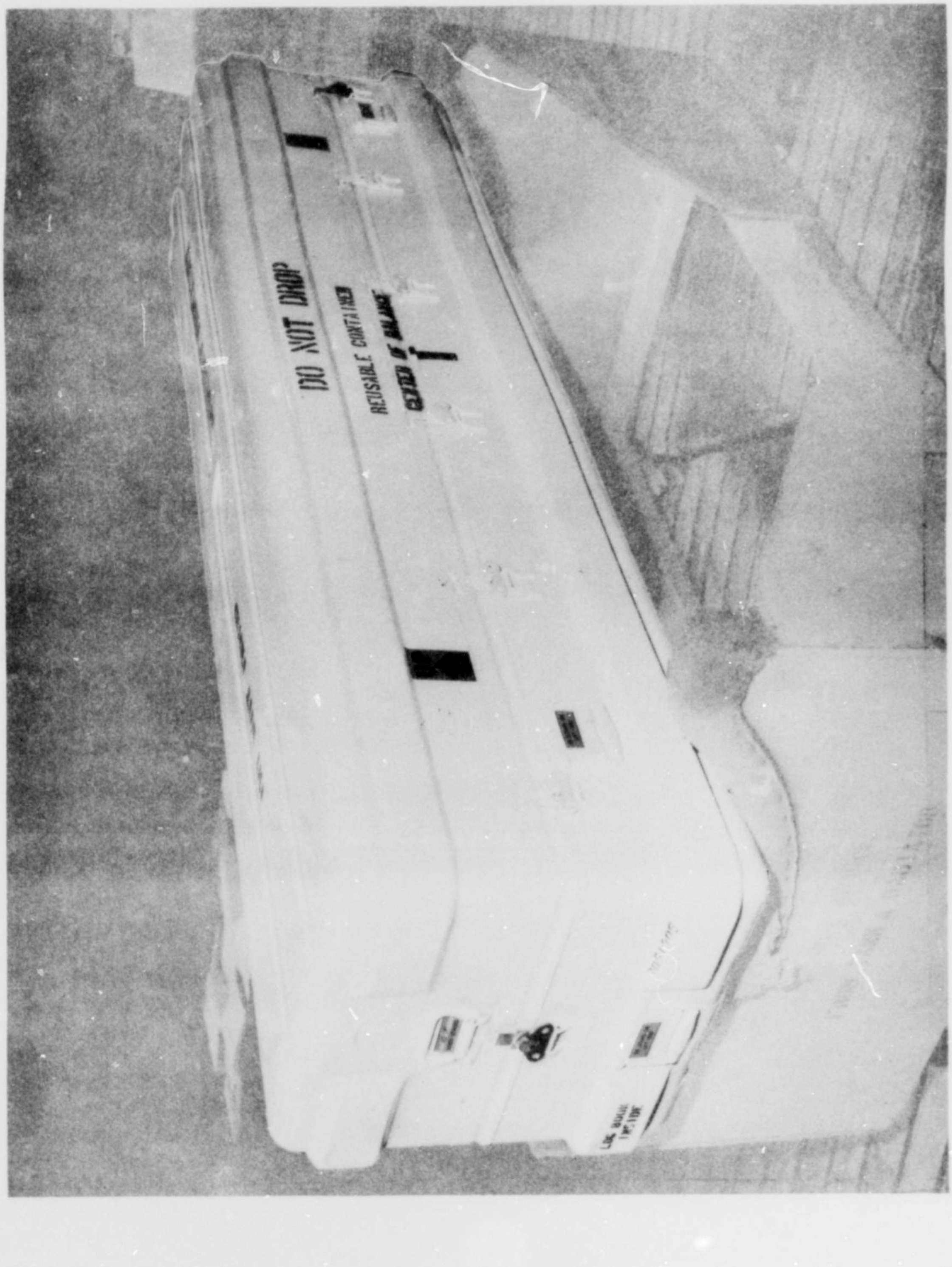
MATTHEW A. VENETOS
Chief, Dynamics Branch
AF Packaging Evaluation Agency

APPENDIX C

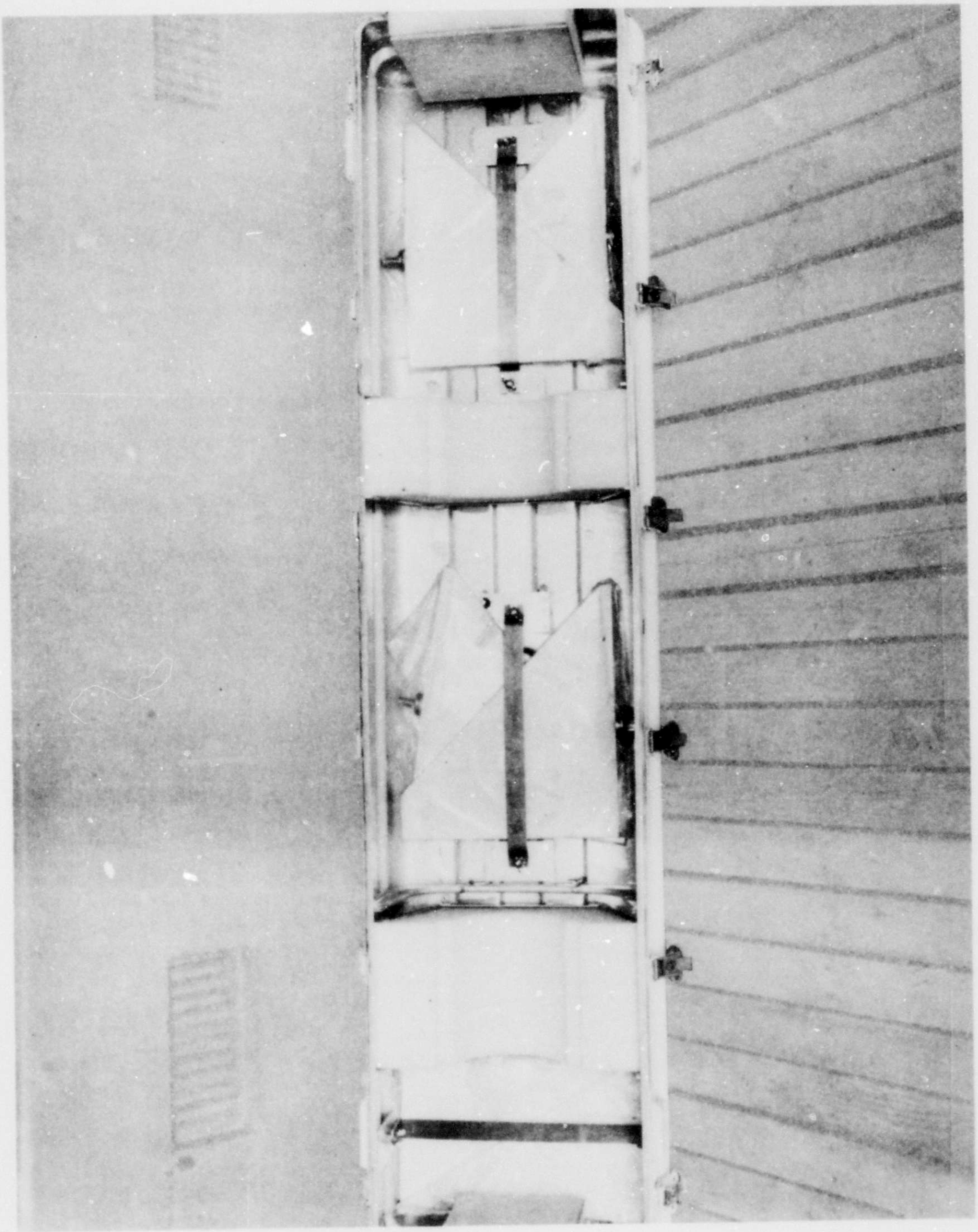
PHOTOGRAPHS



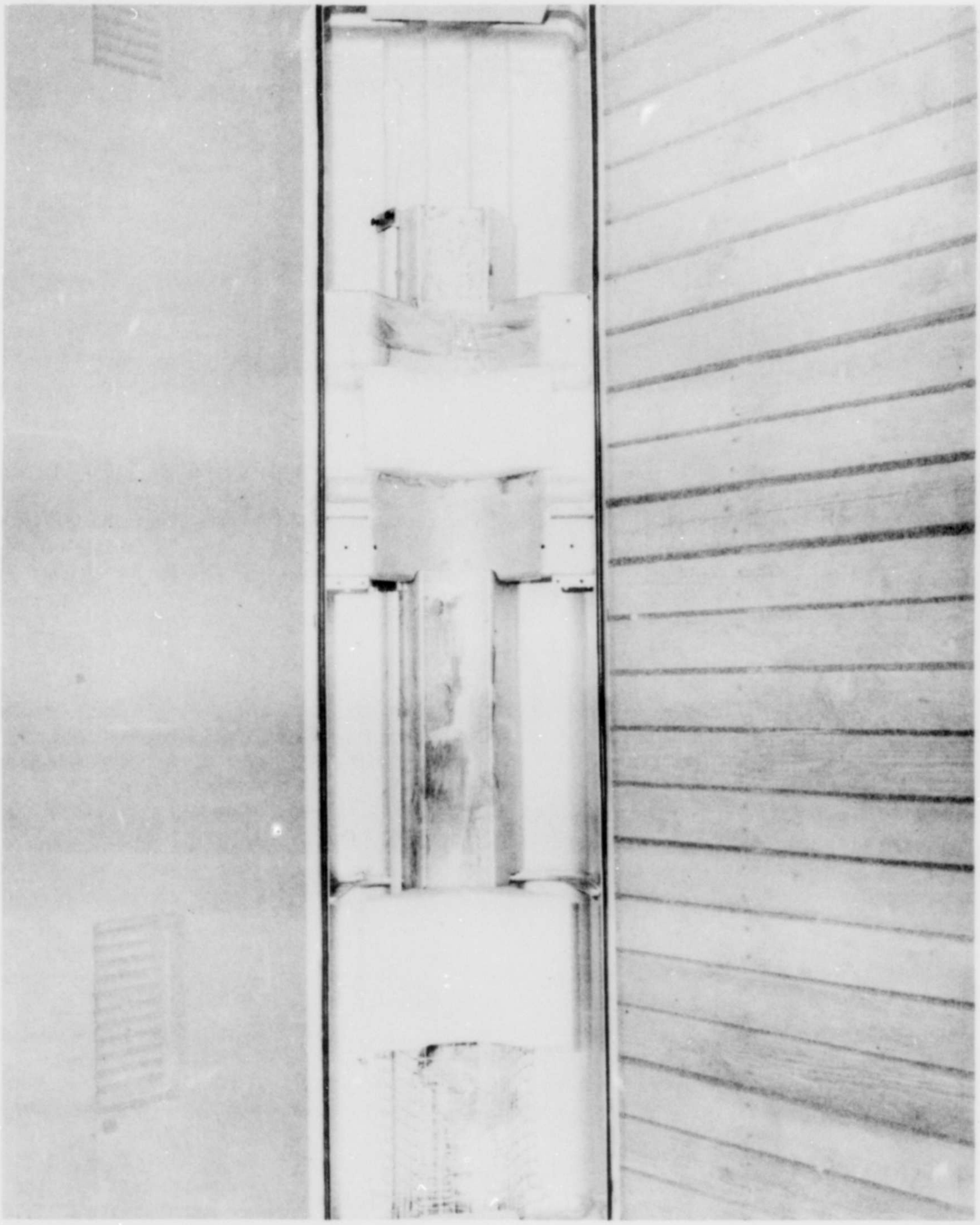
FORWARD END OF CLOSED CONTAINER



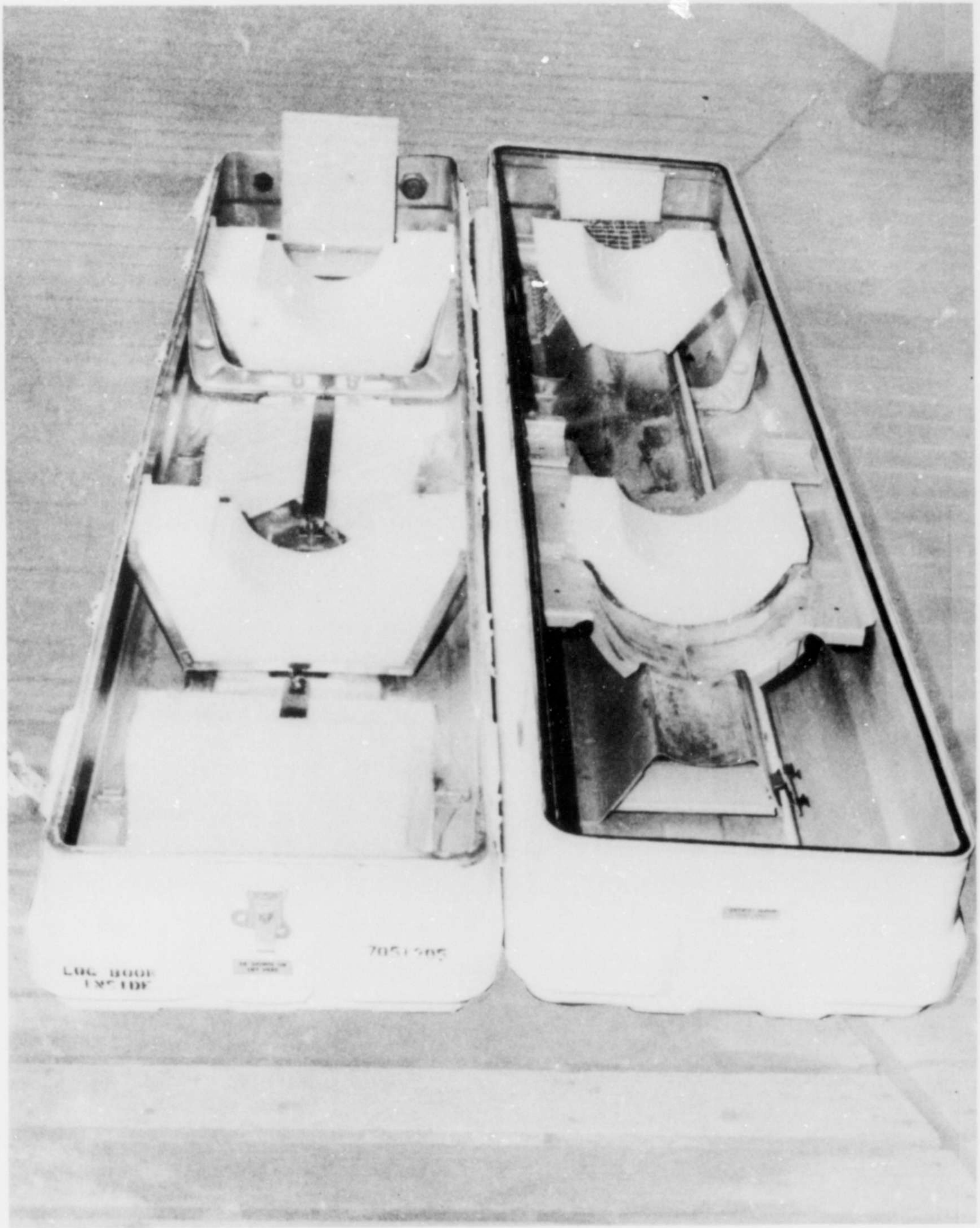
AFT END OF CLOSED CONTAINER



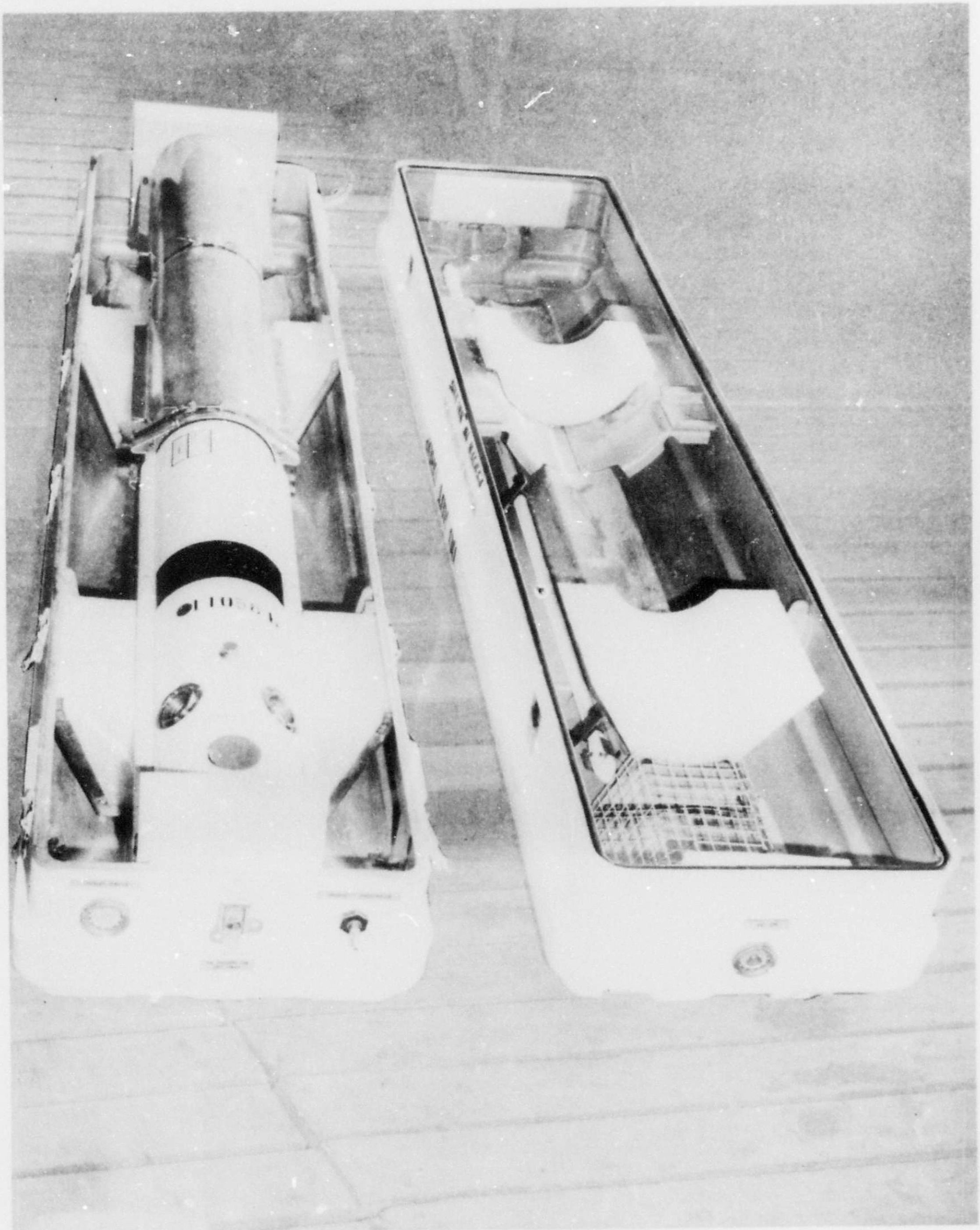
MODIFIED CONTAINER LOWER HALF



MODIFIED CONTAINER UPPER HALF



MODIFIED CONTAINER WITH WINGS, FINS AND ANTENNA



MODIFIED CONTAINER WITH MISSILE AND THRUST SLEEVE

Unclassified
Security Classification

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Modification of AIM-4D Falcon Missile Container to Accommodate Guidance and Control Sections of AIM-7E/E2 Sparrow Missile

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13. ABSTRACT

A shortage of usable AIM-7 missile containers existed and the refurbishment operations were not capable of providing the quantity required. Also the new procurement containers would not be available for several months. Therefore, the possibility of an interim and/or back-up container was investigated.

An AIM-4D Falcon container (FSN 8140-546-3527) was modified to accommodate the guidance and control sections of the AIM-7E/E2 Sparrow missile. The modification included removal of part of the internal structure of the container and replacement of the rubberized hair cushioning material with 2.0 pound density polyethylene cushioning material.

The modified container with an instrumented mock-up of the missile and its components was subjected to and passed two series of rough handling tests in accordance with Federal Test Methods Standard No. 101B, Methods 5005 and 5008, for Level A protection.

Therefore, from the results obtained from the rough handling tests and the fit and function test, it was concluded that the container would provide adequate shock protection for the missile and satisfy an urgent need for an interim and/or back-up container for the guidance and control sections of the AIM-7E/E2 Sparrow missile.

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